

VLBA ACQUISITION MEMO #226

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Subject: Thin Tape Facts

Introduction

Marshall Eubanks' memo "Purchase of D1 Tapes" 14 September 1990 contains some factual errors. These errors, as well as some sins of omission, lead to unduly pessimistic conclusions regarding the cost-effectiveness of introducing the new tape. The conclusion, that operation of a mixed system for as long as necessary and/or desirable is not practical, is wrong.

Tape Length Considerations

A D1K5500M tape is at least 5500 meters (18045') long. At 2 meters/sec 5400 meters are recorded in a 45 minute pass and this may be regarded as the 'working length' with a 50 meter pad on each end for starting and stopping.

Note, there should be no recording while the tape is accelerating and, as set for MkIII, acceleration to 8m/s uses only 21m. Acceleration could be reduced by more than a factor of 2 even for a future possible 8m/s operational speed without overrunning the 50m beg/end pads and this may be recommended to reduce start/stop stresses on the thinner tapes; even lower accelerations could be used as long as the top VLBA speed requirement is 4m/s.

Up to 5550m (18200') of all the tapes ordered for operational evaluation by the VLBA (including 16 micron Ampex D1-equiv and Maxell S-VHS-equiv) can be wound onto a 14" reel, leaving in all cases an adequate 2mm edge margin (difference between reel and pack radius) for handling and a reel band and/or heavy-duty (thicker) leader.

Better Magnetic Performance Needed to Double Area Density

The 1,2,4m/s VLBA operational speeds require reliable operation at 57kfc/i while present MkIIIa operates at 33.3kfc/i; the VLBA mode of operation will also use 14 rather than 12 passes. This means a better tape supporting twice the area density of recording per utilized channel is required.

[Note that MkIII utilizes only 28 of the 36 heads per stack provided and even VLBA uses only 32 for now.]

Cost per bit SonyD1K/SonyV1K = 1.25

Because the VLBA-qualified thin tapes are also twice as long as the type C (professional helical scan video, not conventional instrumentation) tapes we have been using, they can hold 4 times as many bits. Thus if current acquisition cost of the new tape were the only important factor determining the overall cost-effectiveness of their introduction -- and it is certainly not -- we would break even with type C on a cost per bit basis at about \$720 per reel of D1K5500M. At \$900 we are thus paying 1.25 times as much per bit as with type C -- not 2.89 times as Marshall claimed. This is reasonable considering that VLBI is tiny niche market for a tape formulation that has no large market even in the D1-cassette application for which it was designed.

Life-cycle Shipping Cost > 5 Times Price of V1K

If we assume an average shipping cost of \$10 per reel per one-way trip (which is probably low) and that an efficiently utilized tape is recycled 9 times per year then the yearly shipping cost for a 14" reel is \$180 which equals the current price of type C tape such as Sony V1. We expect the tape to have at least a 5 year average service life under these conditions. Thus with MkIII A using type C video tape the life-cycle shipping cost of the tape exceeds its capital cost by a factor of at least five.

With D1K5500M the current capital and life-cycle shipping costs are about equal.

A 5 year program which acquires on average 4 times as much data than at present can thus be run for a total of twice the current shipping costs including purchase of the new tapes. If the same were done with type C tapes, even assuming that no additional ones would have to be purchased, it would be twice as expensive.

Market Facts of Life

D1K5500M is a Sony standard part number; the VLBA is fortunately not the first or only customer but a truly significant market for D1-formulation tape -- never mind whether it is slit and packaged in a large inch-wide or the 19mm cassette format -- may never develop, in which case the price cannot be expected to drop much. The thin tape is cost-effective for VLBI in spite of this real worst-case possibility.

A Hope for Cheaper Good S-VHS Formulation Tapes

I am more sanguine about the possibility that S-VHS tape will increase its share of the consumer market. If our 1"x5500m tape were composed of 45 T-120 S-VHS cassettes presently selling for \$12.50 apiece retail that tape would cost \$562. When and if S-VHS cassettes drop in price to about \$7 I would expect the large reel price to drop to about \$300 or at least reach parity on a price per unit area basis with type C tape.

Instrumentation Tape long Dead for VLBI

It is true that conventional instrumentation tape is technically obsolete -- we abandoned it as quickly as possible 7 years ago in favor of the much better type C video tape -- but this has not caused the bulk of instrumentation tape users to follow suit.

Inch-Wide Tape Lives!

It is not true that the 1"-wide tape is obsolete. Type C professional video helical scan recorders, introduced 10 years ago are now entrenched and represent a large highly competitive market for roughly 250,000 14" reel equivalents per year world-wide.

This market may gradually be eroded by 19mm digital video cassette systems. Most of the new business is going to D2 which uses 13 micron metal particle tape and is cheaper to operate than D1 because it requires only half the data rate of D1, about 16MB/s.

Professional digital high definition TV recorders able to record 1Gb/s+ for an hour exist, at least in beta-prototype form. These \$0.5M machines by Sony, Hitachi, and perhaps others use inch-wide open reel metal particle tape but are otherwise proprietary systems, that is, do not adhere to a common track format standard.

Don't Confuse 19mm D1L Cassette with D1K 14" Reel

D1 stands for digital video type 1 (advanced oxide) formulation, K stands for 1" tape width. D1 and D2(metal particle) formulation tapes are normally slit only to 19mm (3/4") width and packaged in cassettes the largest of which designated L holds only 1338 meters (4390') of 16 micron tape.

The L cassette is about 14" long and Sony may indeed sell it for about \$190 -- it is \$340 on the Ampex price list however -- but it is not a 14" reel of inch-wide tape and holds only 18% as much tape.

This makes the price of the D1L cassette tape quoted to Marshall by Sony about 14% higher on a per unit area basis than the same tape slit to one inch and packaged on the 14" reel, roughly as it should be since the L-cassette has greater fractional packaging overhead.

Operating a Mixed System

Marshall's conclusion, that operating a mixed system of thick and thin tapes (as long as it makes economic and/or scientific sense to do so) is impractical, is wrong.

The question is not whether or how long we will operate mixed tape systems, but how to do it with the least risk, waste of time, and aggravation.

We have done this sort of thing before in switching MkIII from conventional instrumentation to video tape and from wide track to narrow track for example. From much such experience we have gained confidence that similar transitions and the rapid evolution and coexistence of different generations of system components can be properly managed.

Recipe for Coexistence

Specifically, the scenario of many hours of head recontouring by means of shuttling a relatively unabrasive thin recording tape as the only way to switch a processor drive from thick to thin tape playback is grossly pessimistic.

Alan Rogers has already demonstrated the apparently least painful, expensive, and time-consuming of alternatives -- the method of using relatively high tension for the thick and low tension for the thin tape to maintain a compatible contour. Other alternatives include the use of a fast-acting thin lapping tape or the use of separate head assemblies for thin and thick tape with protection against wear by the thick tape of the thin tape contour provided by for example a simple tape lifter.

Processor drives will not have to be dedicated to the exclusive use of one type of tape as long as the recipe for switching between thick and thin tape is followed. The overhead for following the recipe and maintaining cognizance in all operations of which kind of tape is being used should be small.

In principle, but not in practice, the same argument applies to aquisition stations as to processor drives; it is not essential that they become one by one irreversibly 'thin tape' stations. But to establish a simple, orderly, well-monitored upgrade path for the system, such an approach is certainly advisable.

Conclusions

Because processor drives should never lose compatibility with thick tapes in going more and more to the thin, noone need fear that introduction of thin tape will cause whole-sale abandonment of the existing stock of thick tape and 'force' otherwise unnecessary, expensive, large, and possibly premature tape procurements.

The only sound reason for the geodetic VLBI community to invest in new thin tapes is to more cost-effectively satisfy its own need for more recorded bandwidth than can be supported with the present stock and shipping budget. It is certainly not a good reason to do so simply because we would like to be able to process VLBA data as well.